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MINERAL RESOURCES OF THE CARPATHIANS

A. E Feraman
Member of the Academy

A. The History of the Carpathians

If we look at the map of Eastern Europe, it will not be difficult to observe the main orographical elements; the Carpathian ridge, curving to the northeast, and the level area with its many rivers flowing into the great Russian lowlands. On the south, the Carpathian Mountains, approximately 2,500 meters high, fall abruptly on the lowland side, but on the north, west of the San, they are gradually transformed into a hilly area with quite picturesque regions near Krakow. All this orographical structure is connected with the country's past and its geological history up to the comparatively recent moment when the Carpathian peaks began to emerge.

The sea often submerged the South Russian lowlands. Sediments, beginning with the Silurian and Devonian period and ending with the Cretaceous and Tertiary periods, were laid by various formations here on a granite platform which had solidified in the Pre-Cambrain period; these strata were smooth except for folds of the old Sudeten mountains, practically destroyed by subsequent geological phenomena, where the Carpathians now rise.

At the beginning of the Tertiary period, a shallow sea beat against this mountain barrier in the east and the Hungarian mountains in the west; mountain ridges were crushed, sandstones and their conglomerates were deposited, salt and other soluble compounds from limestone or igneous rocks were extracted.

But by the end of the Oligocene and the beginning of the Miocene period, during the great mountain-building process, the Hungarian mountains thrust out to the southeast to meet the solid land which formed the nucleus of northern Russia. The whole Hungarian massif settled, with the Carpathian peaks emerging around it. The sea burst into the lowlands, and along the southern edge of the Carpathians a chain of volcanoes erupted either under water or on the surface of what remained of the old Hungarian matrix.

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Thus the Carpathian Alps ring became just one link in the colossal chain stretching from below the Atlantic Ocean at Portugal to Indochina, seeking weak spots in the earth's crust.

The Carpathian folds overran the lowlands and, where they met the mountains of contemporary Dobruja, they made a sharp turn to the west, forming the contours of Rumania.

The Tertiary sea split into lakes which became shallow; thick strata of rock salt were precipated from national salt deposits, buried under layers of silt or clay.

Luxurious vegetation must have flourished on the shores of these basins, and obviously, the accumulations of brown coal encountered in so many places in Galicia are connected with this vegetation. Research workers are attempting also to connect with it the accumulations of petroleum which some geologists believe were produced by the action of salt solutions on decomposed vegetation.

Such is the geological past of this country, and with it are connected the contemporary geological structure and its mineral resources.

B. The Western Carpathians (Polish Territory)

It was not without reason that, for many years, the borders of three states met at Krakow, the ancient Polish center, between Austria, Poland and Czechoslovakia; here on the map a complicated network of railways catches the eye; here the greatest density of population is shown by the census. It is not without reason that battles have been waged for possession of every foot of this soil and that this historic center, Krakow, arose.

In the complex tectonic and geological structure of the region, nature stored up great resources in this very region; no square kilometer could or should be given up or taken away without serious calculation of the mineral resources concealed under its surface. Coal beds and white or reddish marble, accumulations of rich iron ore, zinc and lead, vast world supplies of salt in Wieliczka and Bochnia, sulfur, fire clay, mineral water--this is a brief summary of the chief mineral wealth.

Glancing over the list of mineral resources, one involuntarily makes a comparison with the inner southern slopes of this same Carpathian range where, in the Miocene period, molten magmas boiled, volcanoes emerged ore veins were incised, and heavy metals accumulated.

There in the valleys of Transylvania (Hungary) beginnings of European ore mines are to be found, rich accumulations of gold, silver, zinc and lead; but these riches had no contact with the outer curve of the Carpathians, and the hot waters from the depths did not cut into the sedimentary rock deposit anywhere on the northeast slopes. The depths of earth yielded few of the elements of its resources; as in the western Alps, orogenic processes contributed little mineral wealth to the slopes of Galicia and Bukovina.

However, we know a little about the countries in Europe, where such considerable accumulations of rock salt extended for so many hundred kilometers, just as may be seen in Galicia, the western regions of the Ukraine, and Bukovina. Deposists of this mineral extend in a continuous strip. In the old Kalusz salt working, relics of stone tools have been found, proving that salt was extracted even in the prehistoric epoch, the Stone Age.

The huge Wieliczka mining operations began not later than the 11th Century, and in the 16th Century, as a bounty on the day of his coronation,

Stefan Batory gave the nobles a right to free salt and metal mining, whereby the country's mining industry was greatly increased. In the course of centuries salt was extracted in enormous quantities, but the method of boiling both natural and artificial brines was generally applied.

Recently, the chief salt mining operations have been concentrated on the famous Wieliczka mines where extraction amounts to 100,000 tons per year.

Wieliczka is, in fact, one of the greatest curiosities of the whole region and a description of its mysterious beauty has long been included in textbooks and popular publications: 16 underground lakes, monuments made of salt, two chapels, a ballroom, etc. But its only interest does not lie in this, but in its really enormous accumulations of salt mined to a depth of 300 meters from a number of independent horizons.

Magnificent crystals of common salt may sometimes be seen in rock salt cavities; a group of crystals from cubes with 20-centimeter edges is preserved in the National Museum at Vienna. Perfectly clear masses of solid salt often attain a size of several cubic feet, and are sometimes as transparent as water.

Other mining was carried on here in western Carpathians on an equal footing with salt: sulfur, a small quantity of petroleum, ozocerite and coal, peat and, on the borders of the South Silesian foothills, zinc and ore.

C. The Eastern Carpathians (Western Region of the Ukraine)

The remarkable central part of the Carpathians, chiefly occupied by our Ukrainian SSR, stretches between the courses of the San and, approximately, the Prut Rivers.

The principal mineral deposits of these regions are mainly located in the southern section of the territory. In this locality there are huge petroleum and gas deposits as well as rock salt and potassium salts. Wide stretches are occupied by phosphorite beds and deposits of brown and, probably, of hard coal. Finally, deposists of bituminous shale, iron ore, and valuable construction material are concentrated here.

It must be assumed that the oldest rock of the Russian territory of the Carpathians--chert, quartzites and crystallized rocks--were concentrated here; among the mineral resources, interesting manganese, graphite and other mineral deposits are connected (in the Chivchin Mountains) with them.

Potassium and various other salts, deposits of fuel gas and perhaps of rare gases, and possibly, petroleum deposits make the region within the borders of the Eastern Carpathians one of extraordinary interest from a practical standpoint; but from the scientific viewpoint also, we shall not find any other region on the whole globe so extraordinarily valuable.

The wealth of coal and, probably, of petroleum resources here is especially valuable: there is a whole great brown coal district (Tarnopol), 10,000 square kilometers in area, with reserves of approximately one billion tons; apparently, in the depths of L'vov itself there lie hidden even more magnificent coal reserves which have as yet only been divined by geologists in vast areas, but which are, unfortunately, very deeply hidden.

There are still more remarkable petroleum reserves. Traces of petroleum in the Carpathians have long been known, but the oil fields

themselves did not come to light until later, at the end of the 19th century. Separate outcroppings of oil in the Carpathians appeared almost everywhere; petroleum often oozed out on the banks and courses of rivers. Petroleum extraction in Galicia in recent years (1938) did not exceed a half million tons, although in 1910 it amounted to 1½ million.

The occurrence of gas in the Carpathians is of enormous importance: fuel gases are connected with petroleum deposists, and they have a great future not only along the whole curve of the Carpathians but in its central regions of Semigradiye.

Ozocerite (mineral wax) deposits have an enormous value, its extraction varying from about 400 to 800 tons per year. There is no doubt that the future of ozocerite is assured by its connection with the success of the ceresin industry, all the more so because there are very large stocks of it in the bowels of the earth. It should be frankly stated that there are no deposits of mineral wax anywhere in the world such as ours in the Soviet Union.

Next in the wealth of resources in the Ukraine region is table salt. This occurs not only in brines, long known in the form of springs, but also in a series of beds, bordering almost all the Carpathians, starting at Krakow and ending with the salt deposits in the depths of Galicia, as far as Bukovina and farther along the southern curve of Rumania.

Here, just in the territory of West Ukraine, about 30 to 40 thousand tons of salt are extracted annually; potassium salts are of especially great importance in these regions; every year about one million tons (1938) are extracted and extraction is increasing every year. These salts are of great economic importance for the whole south of Russia, for without them the country's agriculture cannot be successfully developed.

In the years of the Austrian rule salts had long been known in the Kalusz region, but for a long time, no attention was paid to them since the question was not raised before the Budget Commission of the Austrian Reichstag until (in 1891) the famous geologist Zyss made his brilliant speech on the necessity of thorough research work on accumulations of potassium. Preliminary explorations disclosed the presence of salts in various localities of the triangle formed by Stanislawow, Halicz, and Kalusz; they were subsequently encountered farther north, as far as Stryj and Drohobycz, thus calling attention to a region of great practicable importance.

As in other deposits, the potassium salts represented a top-covering of salt-bearing strata, i. e., they are the last deposits of shallow basins of the Tertiary epoch. These salts of a different chemical composition, do not show continuous strata, but are built up in separate lenses, sometimes approximately 12 meters in width (Kalusz); in places they only impregnate argillaceous rocks, but can be extracted from them by boiling.

Here potash is also associated with various important salts of bromine and iodine. Efficient factories, concentration plants--a whole large-scale industry has been founded on the slopes of the Carpathians, and has great prospects. The potassium and phosphorus of the Carpathians points to enormous resources in the agricultural cultivation of the rich fields and lowlands.

During recent years important deposits of manganese ore have been noted; the occurrence of zinc and lead ores (on the Rumanian border) has been pointed out. Connected with these mineral resources are other mineral bodies as well: iron ore, phosphorite, bentonite, building stone, marble, kaolin, gypsum, graphite, etc.

It is interesting to recall that from the 10th to the 13th Century fine marbled limestone was transported to Kiev from the Carpathian slopes. Amber and mineral crystal were also brought from the shores of the Dnestr and the Dnepr.

It should not be forgotten that here the old north and south routes ran from the Baltic to the Black Sea, also the roads from Greece by the shores of the Black Sea and Tavrida to the cold shores of Scandinavia.

D. Bukovina (Southeast Carpathians)

Finally, we should devote a few lines to the remarkably beautiful South Carpathian Mountains. Here in a setting of turbulent rivers, marvelous beech forests (the name Bukovina is derived from "buk," beech) the deep core of the Carpathian range is revealed and different varieties of crystallized shale mold the shores of picturesque valleys and gorges of countless rivers.

Inside these highly crumpled and ancient strata, conglomerations of heavy metals are encountered and various metal deposits containing lead, copper, zinc and manganese stretch from the north, from the Transylvanian foothills past Karlibaba. This little, lost corner of Bukovina awaits a better future; it is little known and waits for explorers.

Here, many years ago, I began my tour of the Carpathians, and although 30 years have elapsed since then, I learned to love that beautiful country and began to study its minerals. Here near Maramures, I collected beautiful crystal on the banks of the Siret and the Zlato-Bistritsa. I visited the mines where salt was extracted. I acquired a fair knowledge of manganese and gold deposits in the regions near Chernovitz and collected various minerals.

It should be stated that this little western corner of Bukovina has many indications of various mineral resources, and although they are only isolated fragmentary indications of a mineralogical nature, they doubtless arouse great interest. They are discoveries of gold, silver, mercury, chrome, arsenic, zinc, and lead. In close connections with these heavy metals sulfur pyrite deposits were found, which were recently extracted at Fundul-Moldovey and burned to obtain sulfuric acid.

Long ago this extremely rich region of Bukovina attracted the attention of mining promoters, and in 1855 the famous geologist, Kotta very properly stated that this little southwest corner of Bukovina might in the future become "one of the richest regions of Europe," if roads were opened and waterways were utilized.

Nearly 100 years have passed since then, but this region is still little studied by geologists and geochemists. Before us lies a vast historical task--to convert this beautiful old Russian land into industrial and cultivated regions.

E. Mineral Springs of the Carpathians

The mineral resources of the country include not only solid rock and heavy metals, but also waters escaping from the depths of the earth

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and bringing to the surface metals, unknown until recently, and salts, compounds of radium and its decomposition products. Hot mineral springs --those carriers of mysterious medicinal properties--constitute a great national wealth in the country, and without mentioning them, it is impossible to talk about the mineral resources of the region.

But the great curve of the Carpathians did not give us rich mineral springs; their mighty folds did not break the deep surface of the Russian lowlands. Like heavy waves of stone, they merely rolled against its granite fastness. While the molten masses were flowing inside this granite curve, hot springs broke out of the depths, gas-forming eruptive products were given off by planes in the restless ring of the Hungarian lowlands; the periphery of the curve was calmer and young volcanoes hardly made a roadway for themselves anywhere through the great deposits of sedimentary rock.

Only in the west, where the Carpathians leaned on the old structure of the Sudetes, do we see rare, individual hot springs with the typical properties of deep water. Such are the springs of the well-known health and climatic resort, Zakopane, on the foothills of the High Tatry.

But even if Galicia is poor in deep hot springs, she is rich in springs of another type with other elements and of another origin. Waters circulating underground are inevitably enriched by those compounds which we mentioned above; sulfates, ferrous salts, sulfur oxidation products, sediments from old basins of the sea--all this beneath the blanket deposit of the earth's surface is worked over by the under-ground waters, dissolved, recrystallized and precipitated anew, or carried to the surface in the form of medicinal mineral springs.

Thus, numerous springs containing sodium chloride were created in an almost continuous strip extending along the main mountain ridge. Many of them in west Galicia are rich in iodine and bromine, and are therefore medicinal; others, like Szczawnica and Krynica in the narrow valleys of the Dunajec and Poprad basins, are among the most picturesque corners of the Carthians and the most important for the curative properties of their climate.

Bukovina is no less rich in mineral waters. Here special attention should be called to the beautiful health resort Vatra Dornei, well-known for its climate. Here, high in the mountains, close to the Rumanian borders, cold iron springs issue forth, in which a slight radio-activity, related to a radium content in the water, has been discovered.

F. Conclusions

We have tried to draw a picture of the mineral resources of the Carpathians in brief outline. In many places, these resources still lie hidden in the bowels of the earth and await exploitaion. Mining operations and their present conditions are far from equal to these resources, and figures for the total extraction of the mining industry in recent years cannot serve as indexes of the natural resources themselves.

The Carpathians--a remarkable mountain range--still await their discoverers, lovers of [illegible] beauties of nature. They await geologists and scientific medical men who will start a wave of research and transform the Carpathians into a country with a future.

Literature on the Carpathians is magnificent; the number of basic works in Polish, Russian and Czech exceeds 10,000 books. In general, the Carpathian region must be considered a European region which is the subject of special study connected with prospecting for

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petroleum and coal. Much less study has been devoted to the inner section of the Carpathian curve in the territory of the old Austria and Rumania, where many regions require new and supplementary research work.

We must, however, state that not only have the basic problems of the Carpathians not been solved, but the tectonic and geochemical problems still need persistent work. It was simply this interest in the Carpathians which led to the organization of the International Committee on the Study of the Carpathians, which met in various cities, but especially in Prague, Krakow and in Rumania, and put great scientific problems on its agenda, particularly, tectonic and geochemical problems. Now the Soviet Union must head this Committee!

It is not hard for us at present to imagine how to sum up the future of this region, how future research on its natural resources will proceed, and therefore we should know about the natural riches of this old Russian land and take their role in the whole economic life of the USSR into consideration.

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